Psychophysiological Stress in Under-17 Soccer Players

Priscilla Bertoldo dos Santos¹, Katia Maria Kuczynski¹, Thais do Amaral Machado², Ana Cláudia Vecchi Osiecki², Joice Mara Facco Stefanello¹

¹Federal University of Paraná – Brazil. Sector of Biological Sciences – Department of Physical Education. Curitiba-PR, Brazil, ²Faculty Dom Bosco, Curitiba - PR, Brazil

ABSTRACT

Santos PB, Kuczynski KM, Machado TA, Osiecki ACV, Stefanello JMF. Psychophysiological Stress in Under-17 Soccer Players. JEPonline 2014;17(2):67-80. Athletes experience a large number of stressors that can influence their sporting performance. Considering the increased participation of youth in elite sport, the purpose of this study was to examine the psychophysiological stress of soccer players. This study was conducted with a male team of base category soccer players. The Questionnaire Stress and Recovery for Athletes (RESTQ-76 Sport) was used to determine the current state of stress and recovery of athletes. The salivary cortisol (calculation of AUCg) was used to determine the physiological stress. Athletes showed low scores on stress scales and high scores on recovery scales in both training and competition situations (P≤0.05). Only the recovery scale showed a significant difference between the training situation and the game. The athletes demonstrated good recovery ability, since there were no extreme negative emotions suggestive of stress.

Key Words: Psychophysiological Stress, Salivary Cortisol, Soccer Players
INTRODUCTION

The competitive sport presents a variability of stressors (i.e., internal and external pressures not controlled by athletes) that can destabilize physically and mentally the athlete (11,38). However, the different types of pressure experienced by athletes may or may not turn into stressors, depending on the individual's perception. In other words, a specific situation can be considered a factor that causes stress to certain athlete but not for the others. Due to the fact that the perception of stress depends on the evaluation of demands, the quality of resources, and the experiences that the individual has to deal with each situation are crucial (42).

Moreover, the way in which each athlete responds to the referred stressors is also specific and determines how the athlete will be affected by stress (9). It demonstrates that the response to a stressor is a body's complex process triggered by the way stimuli are processed (35). Any kind of stressor stimulus (physical and/or psychological) can trigger psychophysiological reactions that eventually result in hyperfunction of the central nervous system and the endocrine system. As to the latter, in particular, the adrenal glands result in an increase in the release of glucocorticoid hormones (4).

Hydrocortisone (compound F), or cortisol, is the most potent glucocorticoid produced as the final product of the activation of the Hypothalamic-Pituitary-Adrenal axis (HPA). It is responsible for approximately 95% of the glucocorticoid activity of the organism (47). Its production and secretion increase during and after exposure to various stressors (21,23,40). Cortisol has been considered the stress hormone, which can be evaluated in blood plasma, hair, urine, and saliva. Among these ways of evaluation, salivary cortisol is not only an effective measurement, it is more accessible, fast and non-invasive, allowing data collection in a real competitive setting without causing problems of reactivity (40).

The endocrine’s responses to a stressor depends on the personality, sex, and age of the individual (18,30). Samulski and Chagas (39) indicate that young people may have more difficulty in the control of their emotions and reactions when faced with stressful situations more so than adults. This is important since it has been shown that young athletes are more successful when they are able to manage the pressures of competition in sport, overcoming distresses, and uncertainties (5). On the other hand, athletes can experience very high levels of stress from personal pressure to perform well, which can lead them to a premature abandonment of sports practicing (2,32,41).

Most investigations include only professional athletes (6,21,14,29,31), and a few studies (16,21,44) that have investigated the psychophysiologic responses to personal and athletic stressors have shown controversial results. In this sense, the present study proposed to investigate how under-17 yrs of age soccer athletes react to stress experienced in training and competition situations. It was also the purpose of this study to analyze the relationship between psychological and physiological stress of the young athletes in training and competition situations.

METHODS

Subjects

This study was conducted with male subjects under-17 yrs of old from Paraná state in Brazil, using a cluster method. Initially, 28 volunteer players started as a sample in this investigation. The attrition of 10 players (8 players were dismissed by the coach and 2 players with physical injuries stopped), which left 18 players who were subjects in the entire investigation. The team studied (Under-17) was comprised of athletes with a chronological age between 17 (or 61.1%) and 16
(38.9%) yrs of age. The experience of the athletes had an average of 8.3 ± 2.1 yrs of practice in soccer.

The present study was approved by the Ethics Committee in Research of the Department of Health Sciences UFPR, state in Brazil, registered in CEP/SD: 948.073.10.6, as stated in the Resolution CNS 196/96. Before starting data collection, an authorization was required from the club and those responsible for the athletes, through the Term of Agreement Free and Enlightened, keeping the anonymity of the subjects.

**Instruments**
The current state of stress and recovery of athletes (psychological stress) was assessed by the Stress and Recovery Questionnaire for athletes (RESTQ-76 Sport), proposed by Kellmann et al. (22), translated and validated to Brazilian Portuguese by Costa and Samulski (8). The instrument is recordatory that evaluates potentially stressful and tranquilizers events and their subjective consequences of the last 3 days and nights. Its application becomes important in both competition and training, because it allows the evaluation of the connection between the current situation of stress, recovery, and performance expectations during training and competition situations. In addition, the RESTQ-76 Sport is an instrument that allows sensitive assessment of changes in personal states of stress and recovery, presenting stability in short term (from 1 to 2 days) and being clearly able to measure changes between the situations in which it is applied (22). The RESTQ-76 Sport includes 77 items (One is introductory, which is not included in the final score) distributed in 19 scales (Table 1). Each scale contains four items evaluated by a Likert type numerical scale with values ranging from 0 to 6 points (0 = never, 1 = few times, 2 = seldom, 3 = half the time, 4 = often, 5 = very often, 6 = always), indicating the occurrence of events and reported activities.

The values of the scales are calculated by the average values of the respective items. High scores on scales associated with the activities of stress reflect intense subjective stress, while high scores on scales associated with recovery reflect many recovery activities. In general, low scores in areas related to stress and high scores related to recovery are considered positive and vice versa. For this, the interpretation of the results for the present study took into account the variations (0-6) in each scale RESTQ-76 Sport (22), adopting as a criterion for high scores associated with stress and recovery values starting from 4 (often, very often, and always). On the other hand, were considered low scores associated with stress and recovery values 0-2 (never, few times and seldom). Values between 2.01 and 3.99 (half the time) correspond to moderate incidence of stressful events experienced by athletes as well as conditions related to the recovery process.

The assessment of physiological stress levels was performed by means of salivary cortisol concentrations, which are considered good indicators of adrenocortical response, with a convenient and reliable prediction (r = 0.85) with plasma cortisol levels (17, 33), but with the advantage of being easily measured (24). A Salivette® tube was used to collect samples of salivary cortisol, which is a plastic tube containing a roll of high absorbing cotton. According to the protocol recommended by Diagnostic Systems Laboratories, before the athletes placed the roll of cotton in the oral cavity, they performed a mouthwash with distilled water (7).

The unit of measurement used for analysis of cortisol concentrations was nmol·L⁻¹ (nanomol per liter). The saliva samples were analyzed by the kit DSL-10-671000 ACTIVER Cortisol Enzyme Immunoassay (EIA). The ELISA kit was used (a fundamental biochemical and immunological technique) to detect an antigen or antibody in a sample based on antigen-antibody interactions. Salivette® tubes were centrifuged at 1000xg for 5 min.
To control the circadian rhythm of cortisol, the data on salivary cortisol concentrations were entered into a formula derived from the trapezoid, as proposed by Pruessner et al., (34), being the X axis the time (between one and another collection) and the Y axis, the values of saliva cortisol in nmol·L⁻¹. The calculation of the area under the curve (AUC) is a method often used in endocrinology and neuroscience research to understand the information contained in repeated measures over time (34). Values are expressed by the area under the curve in relation to zero (AUCg). The calculation of AUCg allows the researcher to simplify the statistical analysis and increase the power of the test, without sacrificing the information contained in the multiple measurements. It also allows limiting the amount of statistical comparisons between groups (34). In addition, the same calculation has been used in most recent research for obtaining the results referred to the concentrations of cortisol (13,15,36).

The formula for the area under the curve in relation to zero (AUCg) is shown below:

\[
\text{AUCg} = (m_2+m_1) \cdot t_{1/2} + (m_3+m_2) \cdot t_{2/2} + (m_4+m_3) \cdot t_{3/2} + (m_5+m_4) \cdot t_{4/2} + (m_6+m_5) \cdot t_{5/2} + (m_7+m_6) \cdot t_{6/2} + (m_8+m_7) \cdot t_{7/2}
\]

Where \( m \) = the value of each measurement of cortisol, and \( t \) = time interval between one measurement and another.

Procedures
The Questionnaire of Stress and Recovery for athletes (RESTQ-76 Sport) was applied at two different times (after 3 days of training and after the match), emphasizing to the athletes that it was a recordatory instrument, because it evaluates the current state of stress and recovery of the athlete through questions about the last 3 days. The collections of salivary cortisol were performed in different situations: (a) in a resting day; (b) in training situations; and (c) in situations of competition. On the resting day, the athletes did not perform any physical activity for 24 hrs. These collections were aimed at controlling the circadian rhythm of salivary cortisol concentrations in order to gain greater control over the physical effort expended in the training situations and during competition. The samples of the saliva taken are described below.

Collection 1 (C1): in rest (waking up, between 8 a.m. and 8:30 a.m.)
Collection 2 (C2): in rest (half an hour after waking up, between 8:30 a.m. and 9 a.m.)
Collection 3 (C3): in rest (same schedule of training and matches - 9:30 a.m.)
Collection 4 (C4): moments before the first weekly training
Collection 5 (C5): after the end of the first weekly training
Collection 6 (C6) moments before the third weekly training
Collection 7 (C7): after the end of the third weekly training
Collection 8 (C8) moments before the final weekly training
Collection 9 (C9): after the end of the last weekly training
Collection 10 (C10): moments before the decisive match (semifinal match)
Collection 11 (C11): at the halftime of the decisive match (semifinal match)
Collection 12 (C12): after the end of the decisive match (semifinal match)
Statistical Analyses
To compare the physiological stress (AUCg values) between the different situations analyzed (resting, training, and matches), a two way repeated measures ANOVA and Tukey test were used. To evaluate the relationship between the states of psychological stress (scales RESTQ-76 Sport) and physiological (AUCg values) of the athletes in training and during competition situations, the test Pearson Product-Moment Correlation was used. The significance level was set at \( P \leq 0.05 \).

RESULTS
Current State of Stress and Recovery of Athletes
The current state of stress and recovery of athletes was analyzed separately, in training and matches situations.

Current State of Stress and Recovery in Training Situation
The General Stress Scale considers the average of the scales of General Stress, Emotional Stress, Social Stress, Conflicts/Pressure, Fatigue, Lack of Energy, and the Somatic Complaints. The Specific Stress Scale consists of the average of the scales of Disturbances in the Intervals, Emotional Exhaustion, and Injuries. The combination between the averages of the scales of General and Specific Stress represents the average of Global Stress. The scale of General Recovery contemplates the average of scales of Success, Social Recovery, Physics Recovery, General Welfare, and Quality of Sleep. The Recovery Areas scale includes scales of In Shape, Personal Acceptance, Self-Efficacy, and Self-Regulation. The combination between the averages of the scales and General Recovery and Recovery Areas represents the average of Global Recovery (Table 1).

Table 1. General, Specific, Global Stress and General Recovery, Recovery Areas, Global Recovery Scores of Athletes in Training Situation (RESTQ-76 Sport).

<table>
<thead>
<tr>
<th>N</th>
<th>Indicator</th>
<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>General Stress</td>
<td>2.2</td>
<td>1.64</td>
<td>2.9</td>
<td>± 0.4</td>
</tr>
<tr>
<td></td>
<td>Specific Stress</td>
<td>2.2</td>
<td>1.17</td>
<td>3.25</td>
<td>± 0.6</td>
</tr>
<tr>
<td></td>
<td>Global Stress</td>
<td>2.2</td>
<td>1.63</td>
<td>2.82</td>
<td>± 0.4</td>
</tr>
<tr>
<td></td>
<td>General Recovery</td>
<td>3.74</td>
<td>2.65</td>
<td>4.9</td>
<td>± 0.5</td>
</tr>
<tr>
<td></td>
<td>Recovery Areas</td>
<td>4.28</td>
<td>3.44</td>
<td>5.44</td>
<td>± 0.6</td>
</tr>
<tr>
<td></td>
<td>Global Recovery</td>
<td>4.01</td>
<td>3.21</td>
<td>4.83</td>
<td>± 0.5</td>
</tr>
</tbody>
</table>
The Global Stress average of athletes, as well as the averages of scales that constitute General Stress and Specific Stress, was considered moderate. The average of Global Recovery presented by athletes indicates high recovery in training situations. However, when the scales of recovery are analyzed separately, the General Recovery scale was considered moderate and the Recovery Areas scale was high.

**Current State of Stress and Recovery during the Match Situation**

The averages in match situation for scales of stress and recovery achieved by athletes are presented in Table 2.

**Table 2. General Stress, Specific Stress, Global Stress, General Recovery, Recovery Areas and Global Recovery Scores of Athletes during the Match Situation (RESTQ-76 Sport).**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Stress</td>
<td>1.80</td>
<td>0.50</td>
<td>3.43</td>
<td>± 0.7</td>
</tr>
<tr>
<td>Specific Stress</td>
<td>1.95</td>
<td>0.33</td>
<td>3.75</td>
<td>± 0.9</td>
</tr>
<tr>
<td>Global Stress</td>
<td>1.92</td>
<td>0.58</td>
<td>3.17</td>
<td>± 0.7</td>
</tr>
<tr>
<td>General Recovery</td>
<td>3.9</td>
<td>2.1</td>
<td>4.95</td>
<td>± 0.7</td>
</tr>
<tr>
<td>Recovery Areas</td>
<td>4.4</td>
<td>3.0</td>
<td>5.50</td>
<td>± 0.6</td>
</tr>
<tr>
<td>Global Recovery</td>
<td>4.15</td>
<td>3.0</td>
<td>5.23</td>
<td>± 0.6</td>
</tr>
</tbody>
</table>

The average of Global Stress of athletes, as well as the averages of General Stress and Specific Stress scales that compose it, points to low scores related to stress during the match situation. The average of Global Recovery presented by athletes indicates high recoverability during the match situation. However, when analyzed separately, the scale of General Recovery was considered moderate and the scale Recovery Areas was high.

**Physiological Stress (Salivary Cortisol Concentrations)**

To analyze the physiological stress, the resting situations (C1, C2, and C3), training (C4 to C9), and match (C10, C11, and C12) were used to calculate the area under the curve in relation to zero (AUCg) using the trapezoid formula.

Figure 1 shows the average values of AUCg for cortisol concentrations found in soccer athletes Under-17 in the 5 situations evaluated in this study (resting, during training 1, 2, and 3, and during the match). Figure 1 shows that the values of AUCg found in resting and during the match were higher than those found in the training situations.
Relation between State of Stress and Recovery (Restq-76 Sport) and Physiological Stress (Cortisol Concentrations)
The questionnaire RESTQ-76-Sport assessed the state of the athletes' psychological stress and the recovery of the athletes during a 3-day period. This was done to compare the psychological stress with the athlete's physiological stress (i.e., data obtained by calculating AUCg for concentrations of cortisol) during two training situations. Training 1 refers to the 1st wk of training. Training 2 refers to the 3rd wk of training. Table 3 shows the results of the correlation between the scales of stress and recovery of RESTQ-76 Sport, relating to training and match situations, and the values of AUCg obtained during both trainings periods and the match.

Table 3. Correlation between the State of Stress and Recovery and Values of AUCg in Training 1, Training 2, and Match.

<table>
<thead>
<tr>
<th></th>
<th>AUCg Values Training 1</th>
<th>AUCg Values Training 2</th>
<th>AUCg Values Match</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Stress</td>
<td>P = 0.281</td>
<td>P = 0.881</td>
<td>P = 0.872</td>
</tr>
<tr>
<td>Specific Stress</td>
<td>P = 0.222</td>
<td>P = 0.110</td>
<td>P = 0.930</td>
</tr>
<tr>
<td>Global Stress</td>
<td>P = 0.707</td>
<td>P = 0.270</td>
<td>P = 0.903</td>
</tr>
<tr>
<td>General Recovery</td>
<td>P = 0.037*</td>
<td>P = 0.149</td>
<td>P = 0.619</td>
</tr>
<tr>
<td>Specific Recovery</td>
<td>P = 0.429</td>
<td>P = 0.260</td>
<td>P = 0.791</td>
</tr>
<tr>
<td>Global Recovery</td>
<td>P = 0.113</td>
<td>P = 0.149</td>
<td>P = 0.889</td>
</tr>
</tbody>
</table>
It was found a positive correlation \((P = 0.037)\) only between the amount of cortisol (AUCg) and the scale of General Recovery in Training 1. No other statistical associations were found in situations between the scales of stress and recovery RESTQ-76 Sport and values of AUCg.

**DISCUSSION**

**Current State of Stress and Recovery of Athletes**

With regard to the current state of stress and recovery of the under-17 soccer athletes in the present study, extreme negative emotions resulting from overtraining (exhaustion) were not found. These findings are in agreement with Main et al. (27) and McKenzie (28). In fact, the values of low scores in areas related to stress and high scores related to recovery areas are considered positive (22). In both situations (training and match), athletes dealt well with potentially stressful situations.

While it is important to point out that recovery cannot be characterized simply as the absence of stress, it is nonetheless a beginning. The handling of stressful situations is done in numerous ways. First, there are inter-individual and intra-individual psychological, physical, and social steps to reduce stress and restoring the athletes' performance skills (20). Second, it also involves the help of others, particularly qualified professionals that offer physical and psychological preparation, which appears to be the case in this study. Third, however important soccer is to the athletes, coaches, and community, it is also clear, according to Samulski (38), that soccer teams should help subsidize athletes in terms of possible careers and personal development (especially their physical and psychological needs).

When states of stress and recovery of athletes were compared in training and match situations, a significant difference was found for the scale of Global Recovery (composed by the average of the scales of General and Specific Recovery). The average found for training situations and match situations was 4.01 and 4.15, respectively. It is believed that the last training session predating the match (Training 3) is more recreational (last weekly training) and, therefore, may have contributed to a greater recovery of the athletes in the match situation in relation to training. There were no significant differences between any of the scales of stress when comparing the situation of training and match. This result differs from the findings in other studies (9,10,39) and, yet the match is considered as the most stressful factor if not the crowning moment for athletes to demonstrate their abilities regardless of age or level of the practitioner.

The fact that the competitive situation is considered by athletes as less stressful than the training situation may explain these findings. In other words, for having won the previous match against the same opponent with a high difference of goals (6 x 1), the difficulty and importance of the game seem to have been mitigated, creating less stress for athletes. This reinforces the idea that certain environmental factors appear to influence the athlete's perception, providing psychophysiological manifestations that may interfere with the performance of the sportsman (46). Thus, if the most important stressor is an event, it will create the greatest stress for the athlete (given the greater degree of uncertainty of an individual and value with respect to a result or to feelings and evaluations of others) (12,26).

**Physiological Levels of Competitive Stress**

Significant differences in the values of AUCg were found between resting and training situations (1, 2, 3) as well as between trainings (1, 2, 3) and the match. There was not only a difference between the resting position and match, it is noteworthy that the values of AUCg found in training situations were lower than in resting.
The results of this study differ from those found by Salvador et al. (37), Filaire et al. (15), and Rimmele et al. (36) who found significant differences in the values of AUCg between resting situation and the competitive situation. In the present study, the same argument mentioned above also applies in this assessment (i.e., the fact that the evaluated match happened 1 wk after the team's victory over the same opponent by a high balance of goals may have represented less psychological demand of athletes and influenced their perception of the difficulty and importance of the match). Thus, the physiological and psychological demands expended by the athletes may not have been of sufficient intensity to generate significant hormonal discharge. It is noteworthy that high intensities of physical and mental effort are the key to elevations of cortisol concentrations (1). Therefore, this may explain the lack of significant difference between the resting situation and the competitive situation, when both situations were evaluated by the values of AUCg.

The same thinking might have occurred in relation to training. In the week that data collection took place the training volume was lower than in other periods. This was due to the matches in which the team participated weekly. As an example, much of the training 3 (the 5th and the last weekly training) had a recreational character, in which athletes played in all the positions without specific functions (a match simulation called by soccer players as "rachão" that approximates the English term "big share"). A larger volume of training has been associated with a higher cortisol concentration in athletes, while a smaller volume of training leads to lower concentrations (3). Moreover, when physical stress is observed at moderate intensity, it does not constitute a sufficient stimulus capable of causing significant elevations in cortisol secretion unless it is accompanied by a great mental effort (45).

**Correlation between the Current State of Stress and Recovery (RESTQ-76-Sport) and the Current State of Physiological Stress (values of AUCg) in Situations of Training and Matches**

The correlation between indicators of the physiological and psychological stressors is to some extent controversial, which is the case in Filaire et al. (16). There is even disagreement in other studies (21,44). Interestingly, in the present study, the correlation was found only between the scale of General Recovery RESTQ-76-Sport and AUCg value (related to the concentration of salivary cortisol) in Training 1. The correlation may be explained by a resting period that allows the athlete to use recovery capabilities against possible situations that cause stress. Steinacker et al. (43) observed a correlation between the scale of the Somatic Complaints RESTQ-76-Sport and salivary cortisol concentrations during the most intense training of high yielding rowers. When monitoring the relationship between the rapid increase in the volume of training, performance and state of stress and recovery in junior rowers, Jurimae et al. (19) observed an association between concentrations of cortisol and stress scores (scales of RESTQ-76-Sport). In opposition, Maestu et al. (25), who monitored the Estonian Olympic Rowers training, found a positive correlation between the increase in training volume and the scores of the stress RESTQ-76 Sport, as well as an inverse relationship with the scales of recovery. However, the cortisol concentrations did not change throughout the study.

**CONCLUSIONS**

The low scores of stress and the high scores of recovery found in the RESTQ-76 Sport scales in both the training and competition situations indicate that the athletes were adequately dealing with situations associated with stress. The analysis of physiological levels of stress presented by the athletes in those different moments evaluated (resting, training and competition) demonstrates significant differences between the values of AUCg for the most of the situations analyzed (i.e.,
between resting and training and between training and matches). However, a significant difference was not found between the values of resting and situations of training and competition. These results suggest that the psychophysiological demand of soccer might not be sufficient to generate hormonal discharges.

Regarding the relation between the states of psychological and physiological stress, a significant correlation was found only between the General Recovery scale of RESTQ-76 Sport and the value of AUCg (referring to the concentration of salivary cortisol) in Training 1. This finding can be explained primarily by the resting periods that made it possible for the athlete to use recovery resources to reduce stress. Also, it is likely that the low psychological demand for a week after the team’s winning over the adversaries with a high balance of goals may have influenced athletes’ perception over the difficulty and importance of the match.

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Address for correspondence: P. B. Santos, Universidade Federal do Paraná - Departamento de Educação Física R. Coração de Maria, 92, Jardim Botânico – Curitiba–PR–Brazil – Zip code: 80215-370 Phone 00 55 41 3360-4333; FAX 00 55 41 3360-4336, E-mail: pibertoldo@gmail.com

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